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Title: Geomorphological evidence for pervasive ground ice on Ceres from Dawn data

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Abstract

Five decades of observations of Ceres have explored the likelihood that the innermost dwarf planet boasts an ice rich bulk composition. We report geomorphological evidence from Dawn Framing Camera data suggesting that its surface has likely been shaped by surface and/or shallow subsurface ice, including possible evaporative and flow processes within silicate-ice mixtures. Here we highlight three classes of features that possess strong evidence for ground ice. First, ubiquitous craters with scallop-shaped rims, in some cases “breached,” are characterized by mass wasting processes and by the recession of crater walls in asymmetric patterns; these could be influenced by processes analogous to those in sublimating ice-rich terrain on Mars and those formed by mass wasting in terrestrial glaciated regions. The degradation of crater walls appears to be responsible for the nearly complete removal of some craters, particularly at low latitudes. Second, several high latitude, high elevation craters feature lobed flows that emanate from cirque-shaped head walls and bear strikingly similar morphology to flows on other ice-rich planetary surfaces. Possible similarities to terrestrial rock glaciers include lobate toes and indications of furrows and ridges consistent with flow of ice-cored or ice-cemented material. Other lobed flows persist at the base of crater walls and mass wasting features. Many flow features evidently terminate at ramparts. Third, there are frequent irregular domes, peaks and mounds within crater floors that depart from traditional crater central peaks or peak complexes. In some cases the irregular domes show evidence for high albedo or activity. One possible formation scenario could include extrusion and refreezing of subsurface water, forming domes in similar processes to ice lens formation in pingos. The distribution of these classes of features, including latitudinal variation in their abundance and/or appearance, suggests that ground ice is a key controller of geology on Ceres, and that ice content within the surface and subsurface is spatially varied and/or activated by energetic events.

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